# Extreme Working Group Summary

Xiquan Dong and John Albertson, Co-Chairs

And Extreme Working group members

NASA ENERGY AND WATER CYCLE STUDY

NEWS

# There are four sections

1) Overview of research highlights
2) Future studies of extreme events
3) Outline of papers
4) Plans for future working group meetings

# Goals of this group for next 5 years

1) To understand the mechanisms responsible for water and energy extremes.
2) To investigate their relationships with continental and global scale processes.
3) To assess their predictability and feedbacks in the context of bridging climate and weather scale.
4) This group places a high priority to enhance, reconcile, and share novel datasets to diagnose the above issues

# Section 1

Overview of research highlight from the two golden years at the SGP region, and work as a team to investigate the 2006 drought and 2007 flood extreme events

# Why we select two golden years as our group effort

1) From historical overview, droughts and floods occurred over SGP quite often as shown in Dr. Dai's presentation and in our study (strong regional signals).
2) Droughts could occur during either Winter or Summer, but floods mostly occurred during Summer.
3) However, there are NO such two highly contrasting extremes occur within two consecutive years.
4) No such a comprehensive dataset available concerning the droughts and floods in the SGP relative to other periods in history.

# Precipitation Characteristics in Summer 2007 Oklahoma Extreme Events

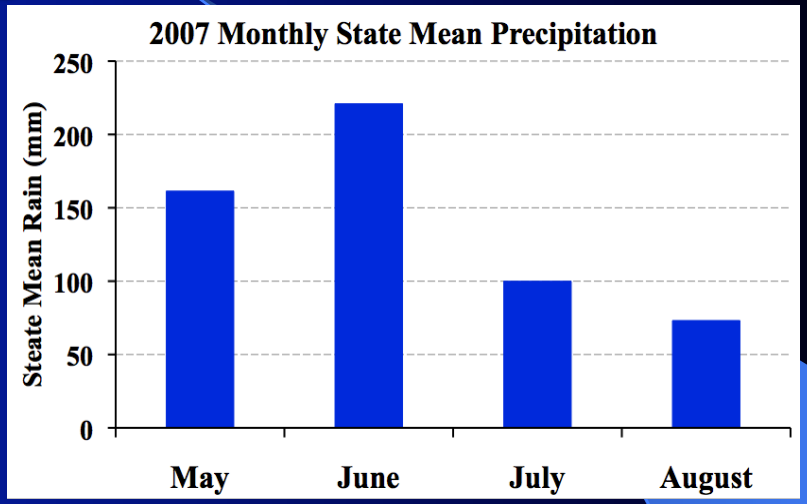
**Zhe Feng, Xiquan Dong, and Baike Xi**

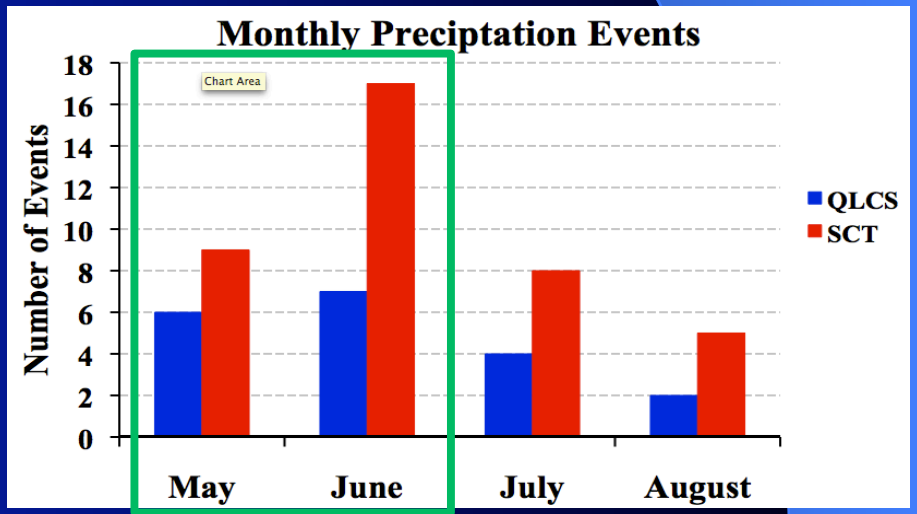
**University of North Dakota**

**Dec 2, 2009 NASA-NEWS**

# 2007 Summer Season (May-July in this study)

- The total precipitation during summer 2007 > 400 mm.
- Major precip events occurred during May-July 2007
- Multiple organized convective events (QLCS) occurred in May and June



# Investigation of 2007 Summer Extreme Precipitation Events Using an Integration of Observations and WRF Simulations

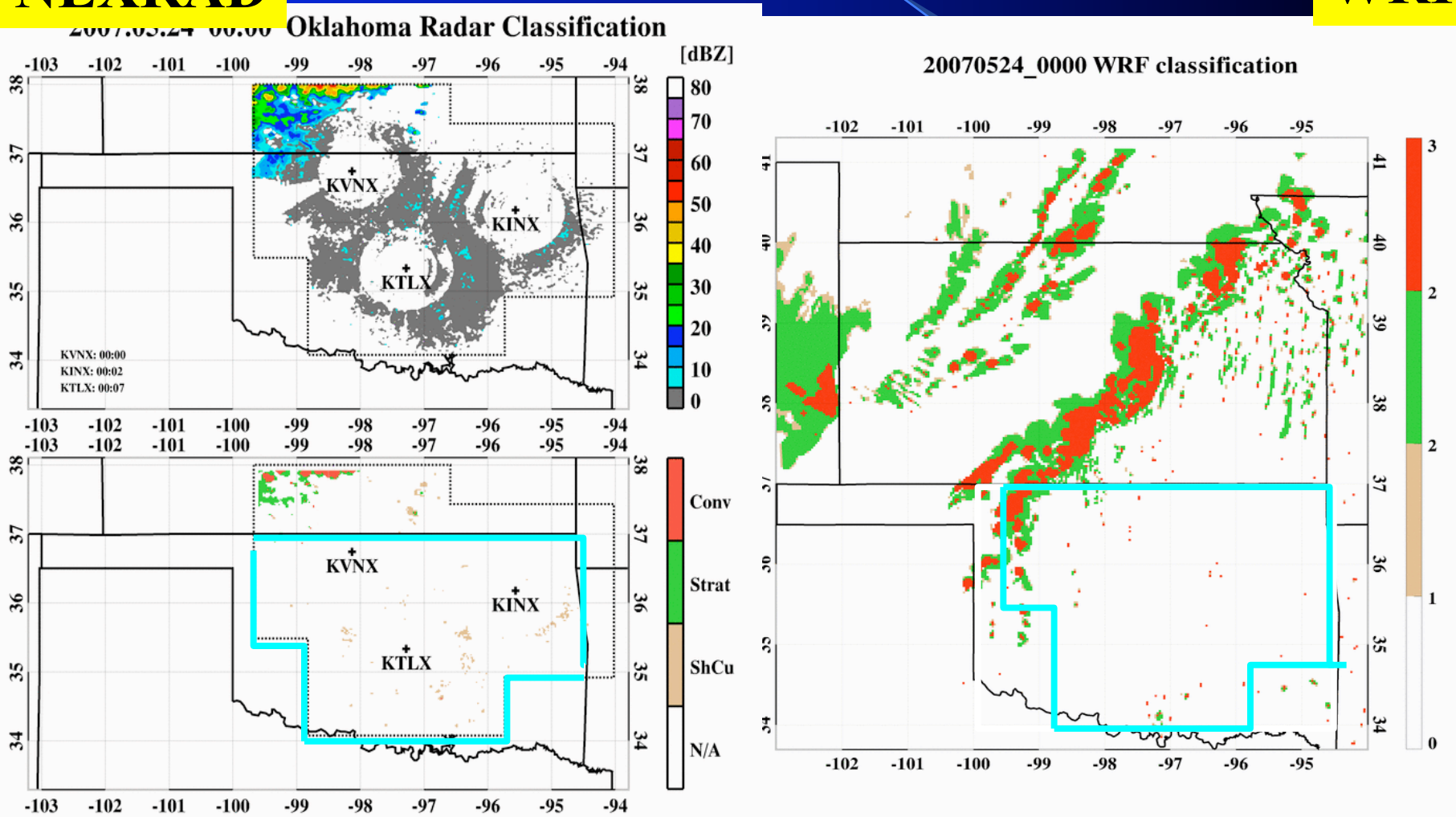
Di Wu, Xiquan Dong, Baike Xi, Zhe Feng, Aaron Kennedy, and Gretchen Mullendore

University of North Dakota

# Comparison between radar and simulations

**NEXRAD**

**WRF**

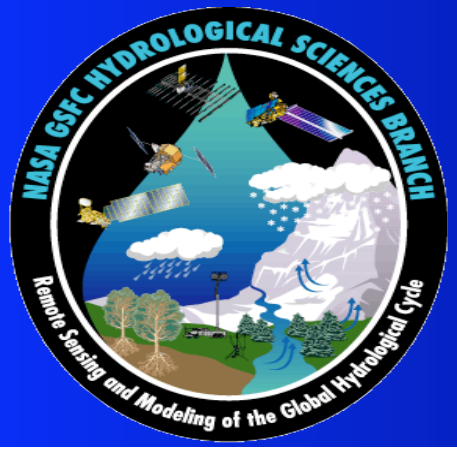


# LoCo Diagnostics and LIS-WRF Experimental Design for the 2006-7 Period

**Joseph A. Santanello, Jr.**

**Hydrological Sciences Branch**
**NASA-GSFC**

**Christa Peters-Lidard (NEWS PI), Sujay Kumar (GSFC)**
**NEWS Collaborators: Mike Bosilovich, Randy Koster, Rolf Reichle, Matt Rodell, Xiquan Dong**
**External Collaborators: Bart vd Hurk (KNMI), Mike Ek (NCEP), Eleanor Blyth (CEH), Cor Jacobs, Obbe Tuinenburg (WUR)**





# Drought Persistence in the Southwestern US: *A Preliminary Analysis*

**John Albertson**
**Civil and Environmental Engineering**
**Duke University**

# A Comparison of Atmospheric State, cloud, radiation and precipitation between NARR, MERRA, and ARM Forcing

**Aaron Kennedy, Xiquan Dong, and Baike Xi**

**University of North Dakota**

**Shaocheng Xie, DOE LLNL**

**Junye Chen, NASA GSFC**

# SST variation related to the drought and flood?

Tim Liu, JPL

# Using Satellite Precipitation for Extreme Events Analysis

B. Imam, S. Sorooshian, K. Hsu,
X. Gao

# Section 2: Future studies

- After we have done the analyses of two golden years, what future projects and other extreme events our extreme group will work on?

# Future Project 1

**How do the regional extreme events (like the two golden years at SGP) link with continental (Bing Lin) and global scale (Yi Deng) processes?**

# Title slide

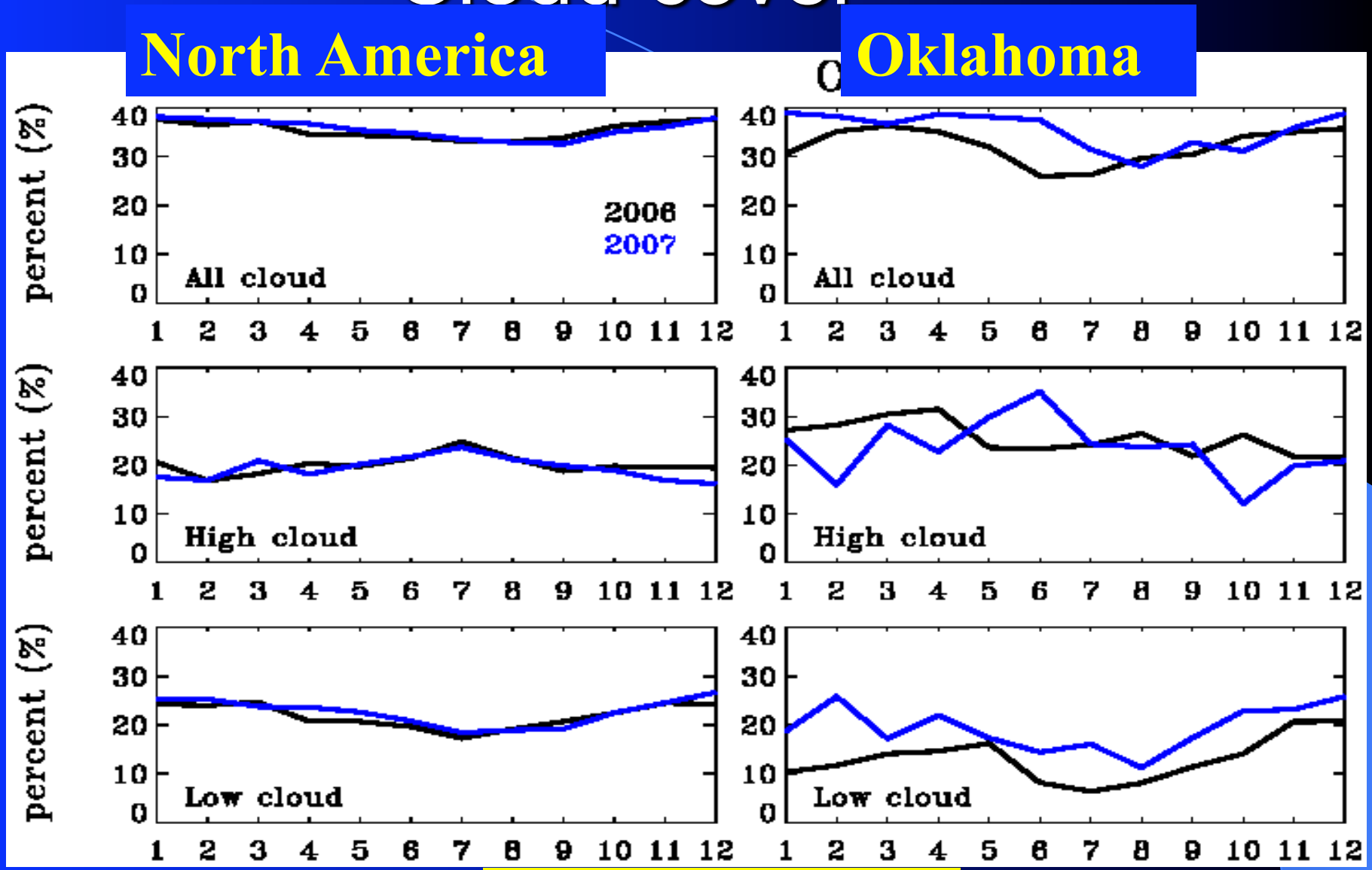
# Clouds and radiation variations during the two extreme years

Bing Lin[1] and T.F. Fan[2]

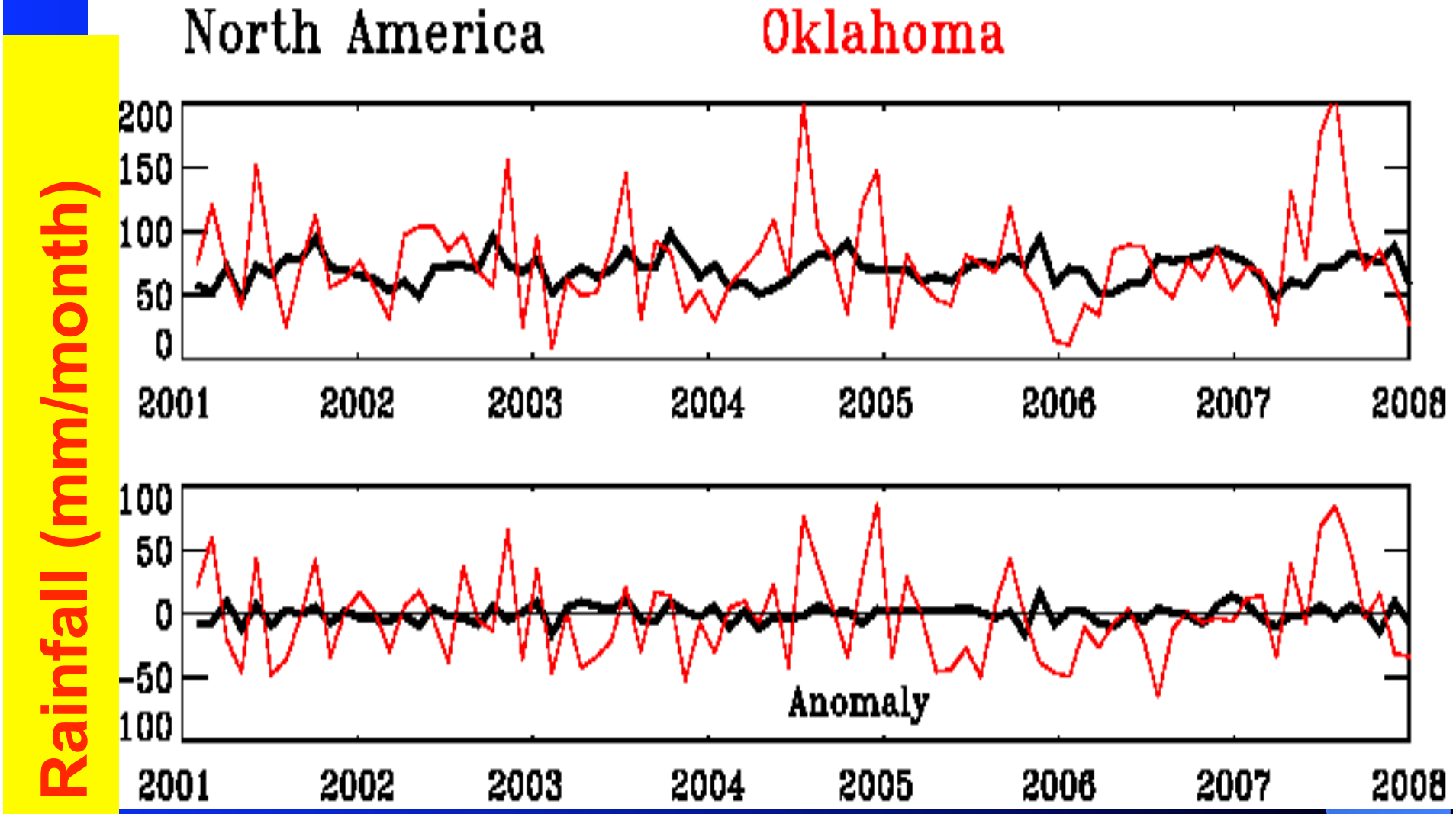
[1]NASA Langley Research Center, Hampton, VA
[2]SSAI, Hampton, VA

NEWS Science Team Meeting
Columbia, MD, December 2-3, 2009

# Cloud cover


North America
Oklahoma
percent (%)
All cloud
High cloud
Low cloud
2006
2007
0
10
20
30
40
1 2 3 4 5 6 7 8 9 10 11 12
Time (month)

# GPCP precipitation



# Dynamical Control of the Extratropical Storm Tracks on the Occurrence of Winter Hydrological Extremes in the U.S.

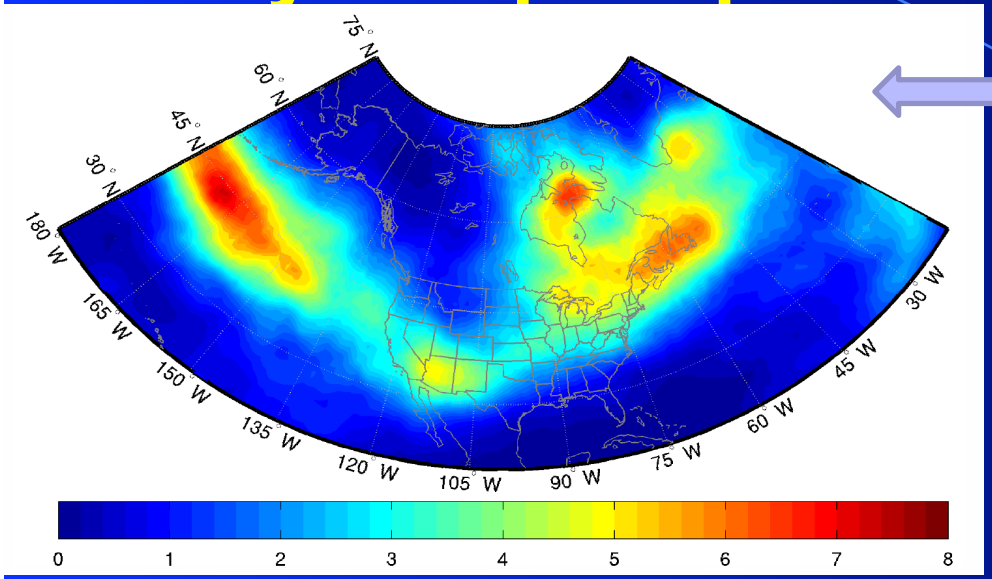
## Application to the 2006 drought event over the SGP region

Yi Deng

School of Earth and Atmospheric Sciences
Georgia Institute of Technology

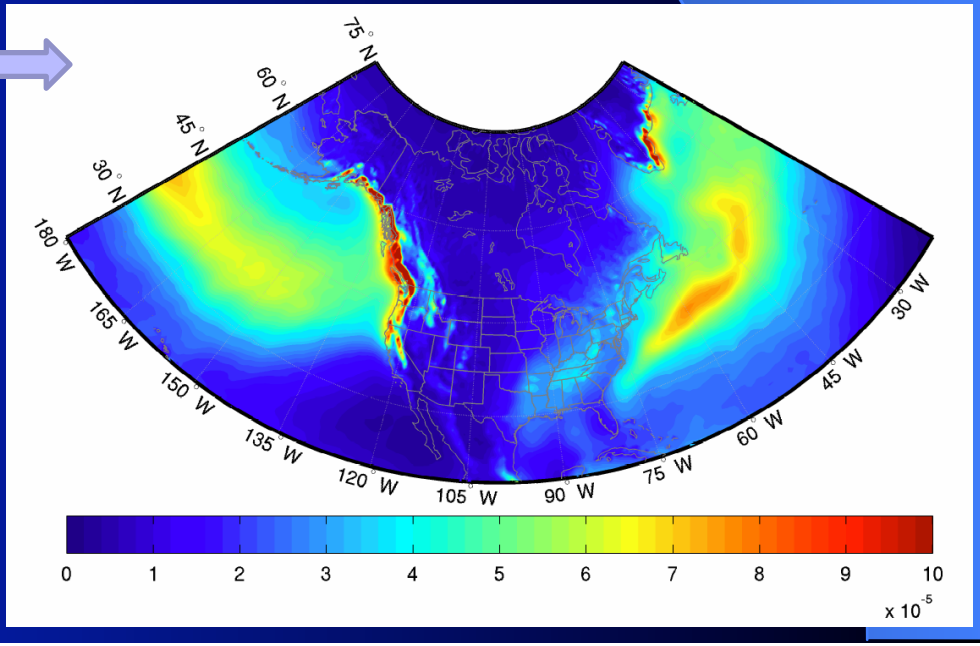
NASA NEWS PI Meeting, Columbia, MD
December 2, 2009

# Relative distribution of the winter cyclonic activity and precipitation



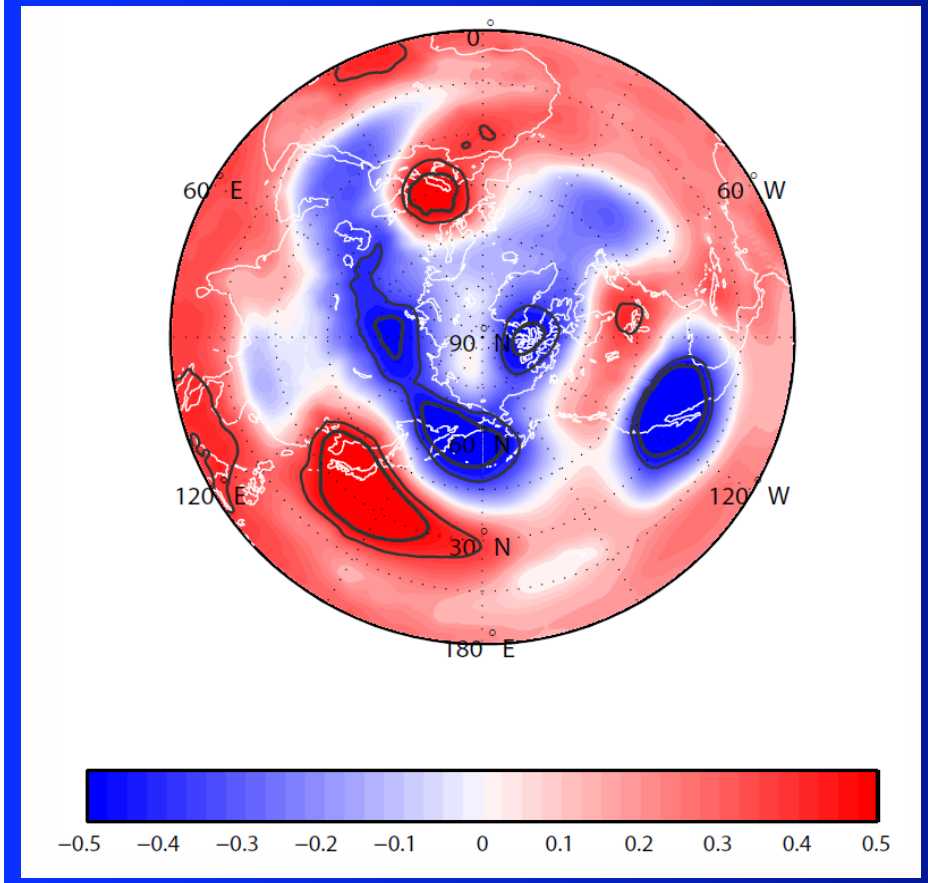

Winter climatology of the cyclonic activity based on the period 1979/80 – 2005/06

Winter climatology of the precipitation based on the period 1979/80 – 2005/06

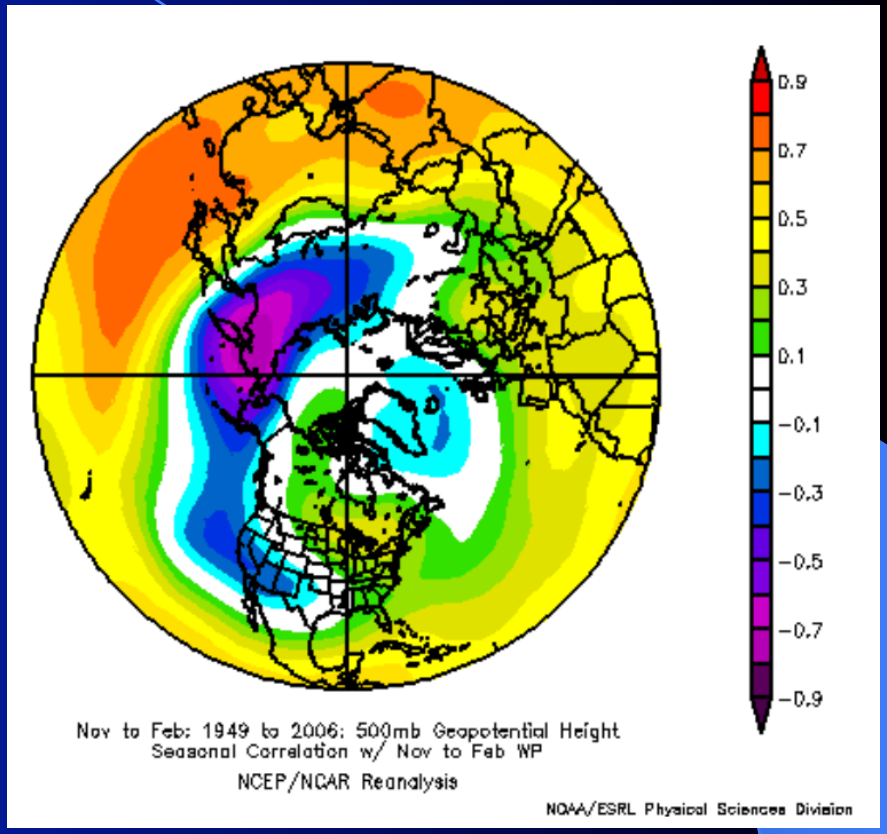


# Case 1: the 2006 drought event over the SGP region

**Is the upper level cyclonic activity over the southwestern U.S. linked to remote, large-scale processes/variability? – sources of predictability**




**Correlation between the Nov-Feb averaged 500mb geopotential height and the CAI**




**Correlation between the Nov-Feb averaged 500mb geopotential height and the index of the West Pacific (WP) teleconnection pattern**

# Future Project 2

**How to assess the predictability and feedbacks of these regional extreme events (Adam Schlosser)**

# Future studies of Extreme Events?

1. The minimum Arctic ice extent during Summer (Behn Zib and Xiquan Dong)
2. New and old Arctic snow coverage during Fall and Winter (Yi Deng)
3. Snow coverage over Tibet Plateau and intensity of East Asia Summer Monsoon (Bing Lin)
4. Drought persistence over California (Soroosh Sorooshian, Son V Nghiem, Yi Deng)

# Comparison of Two Extreme Minimum Arctic Sea-Ice Extents:

## The Record High in *1996* and Record Low in *2007*

**Behn Zib, Xiquan Dong, and Baike Xi**

University of North Dakota

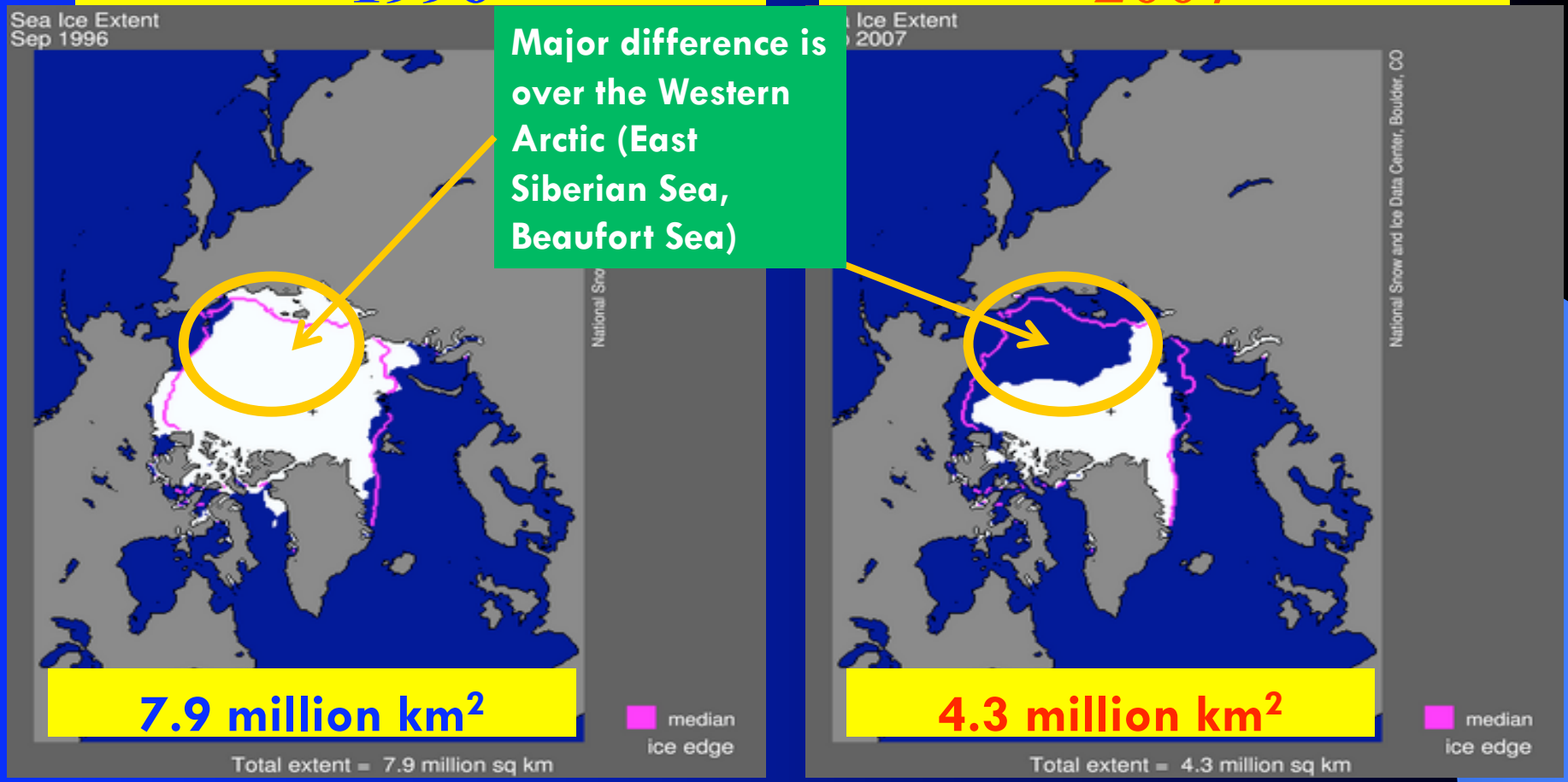
NASA ENERGY AND WATER CYCLE STUDY

NEWS

# Minimum Ice Extent Comparison

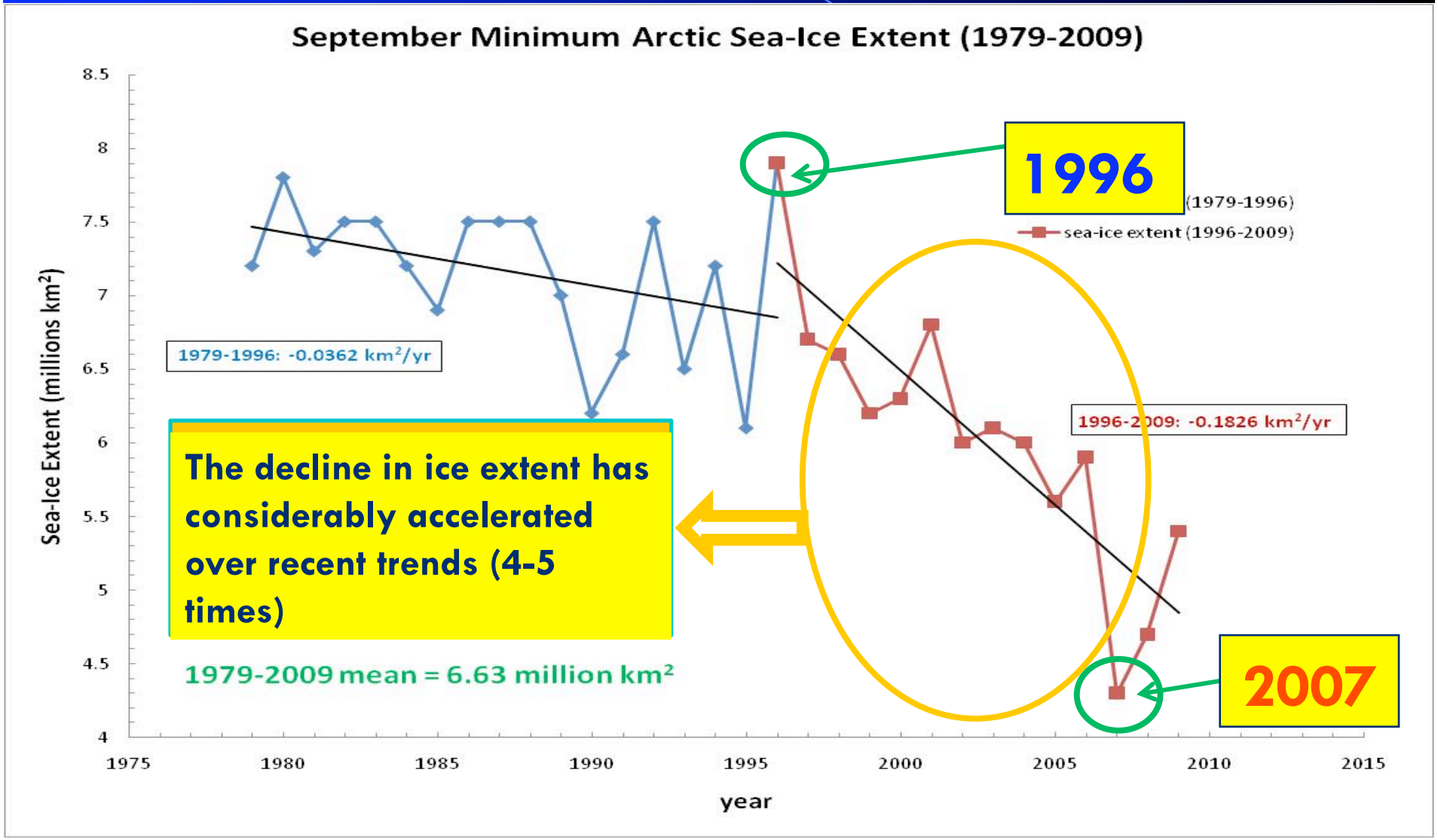
**1996**

**2007**




Images are derived from passive microwave satellite data and depict the most recent daily sea ice conditions. Extent images show the total area of ocean covered with at least 15% ice.

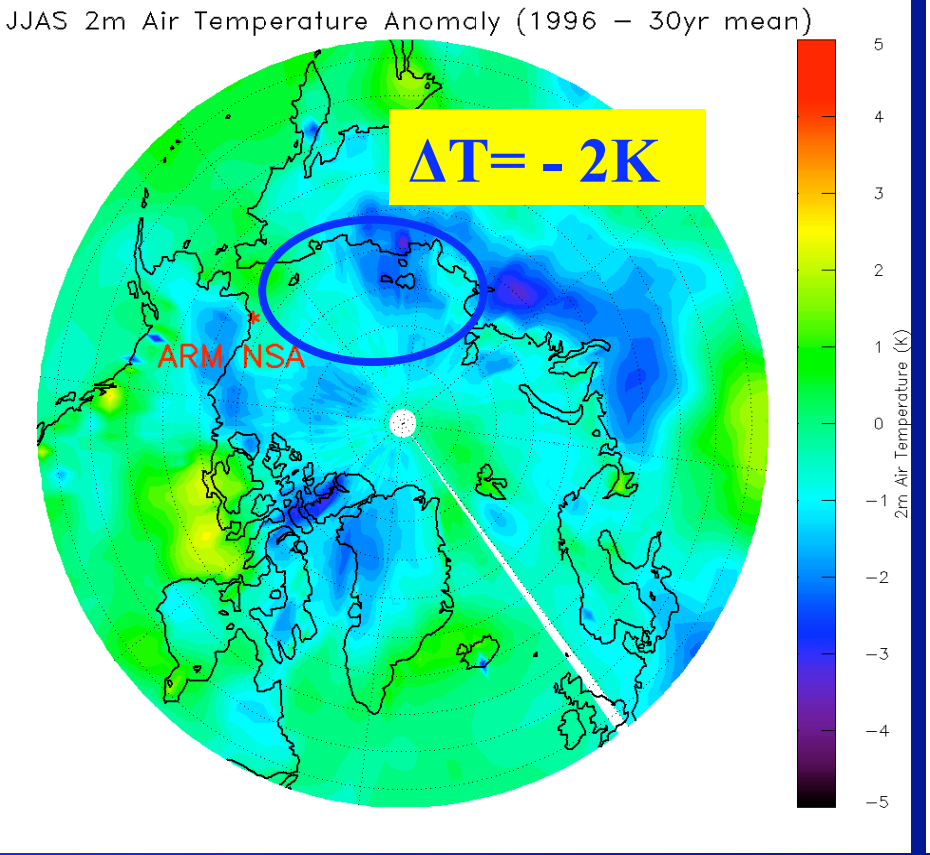
# Trends in September Arctic Sea-Ice extent (1979-2009)



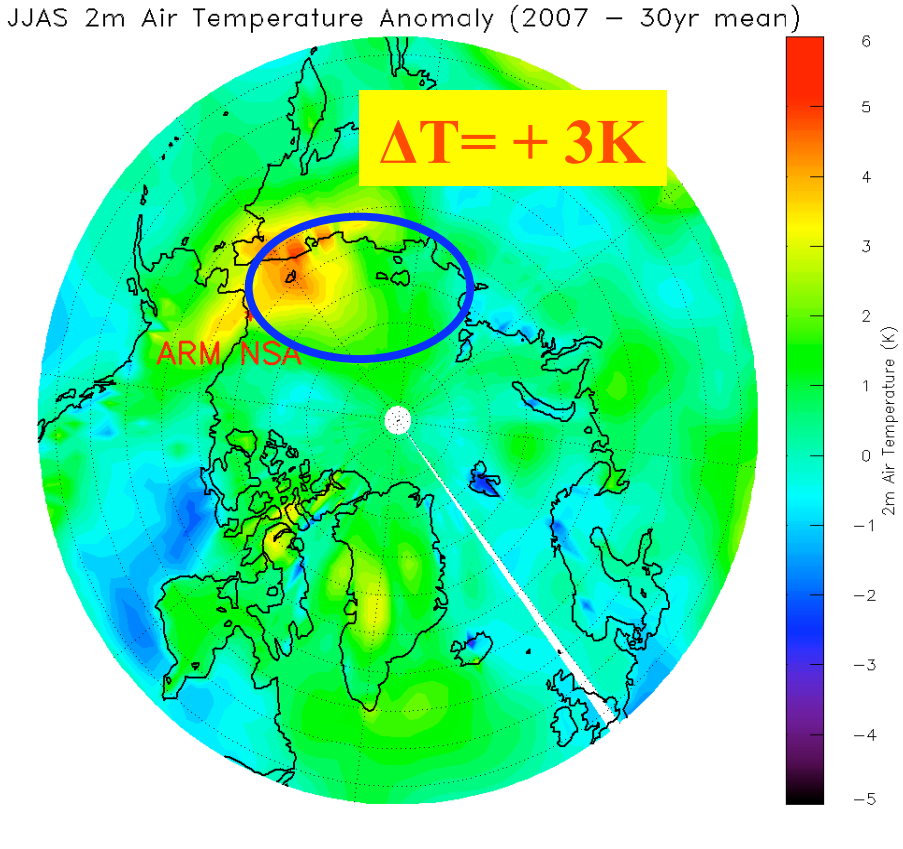
# (JJAS) 2m Air Temperature Anomaly

**(anomalies based on 30 year mean from 1979-2008)**

## 1996 Anomaly



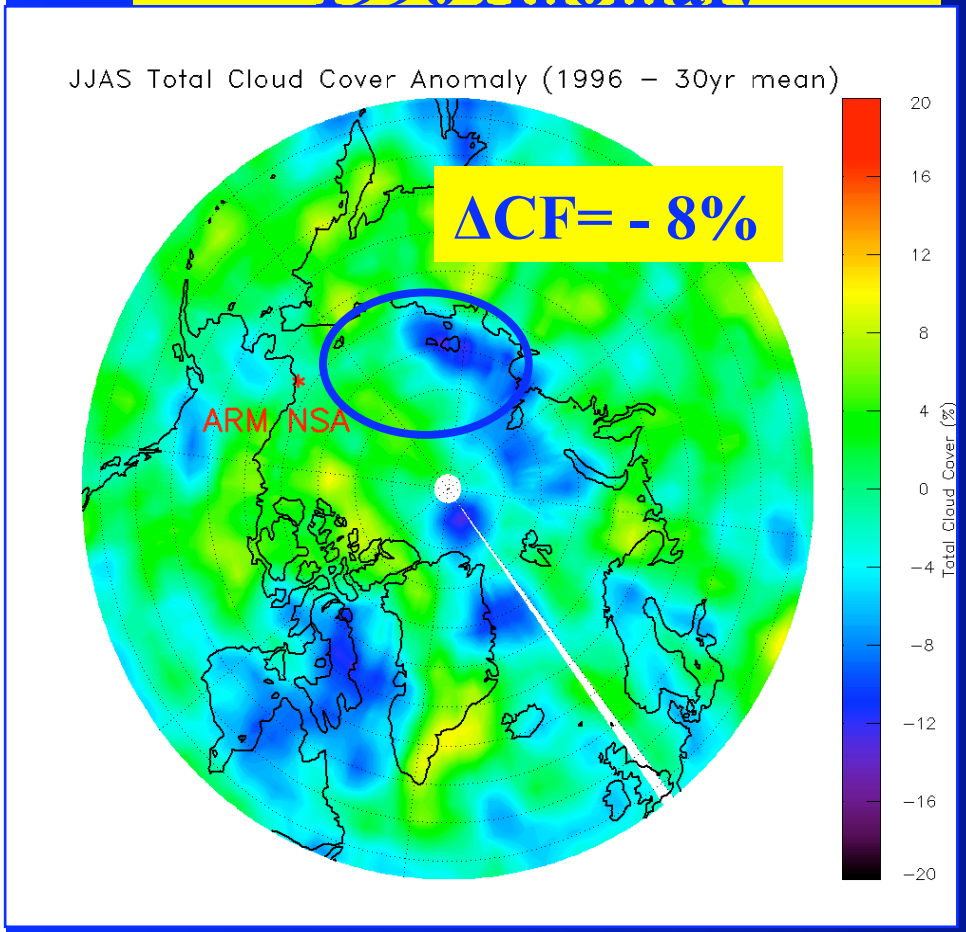

## 2007 Anomaly



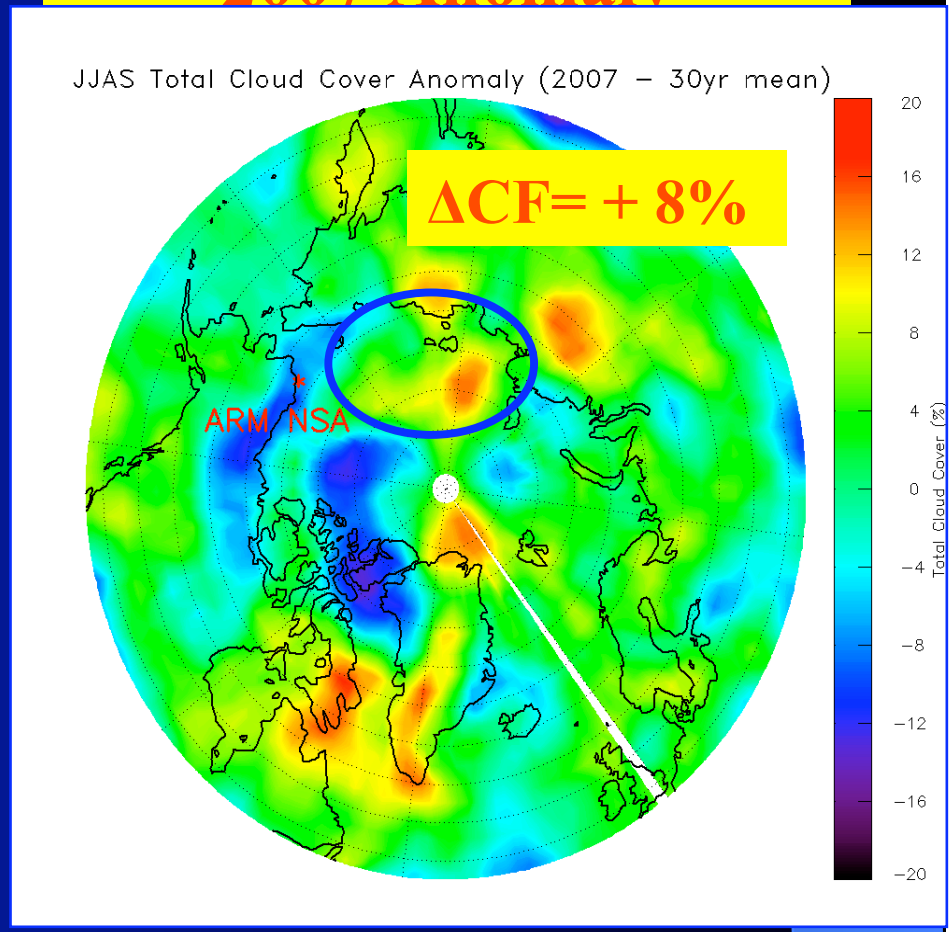
# (JJAS) Total Cloud Cover Anomaly

## (anomalies based on 30 year mean from 1979-2008)

### 1996 Anomaly




### 2007 Anomaly



# Section 3: Publications

(should be submitted before next NEWS STM)

1. Dong, X., B. Xi, A. Kennedy, Z. Feng, J. Entin, P. Houser, B. Schiffer, W. Olson, T. L'Ecuyer, T. Liu, K-L Hsu, B. Lin and Y. Deng, Investigation the 2006 Drought and 2007 Flood Extreme Events at the SGP using an Integrative Analysis of Observations. Resubmit to JGR -atmosphere.
2. Zhe Feng and Xiquan Dong et al. 2010: Precipitation Characteristics in Summer 2007 Oklahoma Extreme Events Observed by NEXRAD and MESONET. In preparation for J Tech.
3. Di Wu and Xiquan Dong et al. 2010: Investigation of 2007 summer extreme precipitation events using an integration of observations and WRF simulations. In preparation for Monthly Weather Rev.
4. Aaron Kennedy and Xiquan Dong et al.2010: Comparison of ARM observations, NARR, and MERRA over the SGP region during the period 1999-2001. In Preparation for GAMO special issue or JGR -Atmosphere

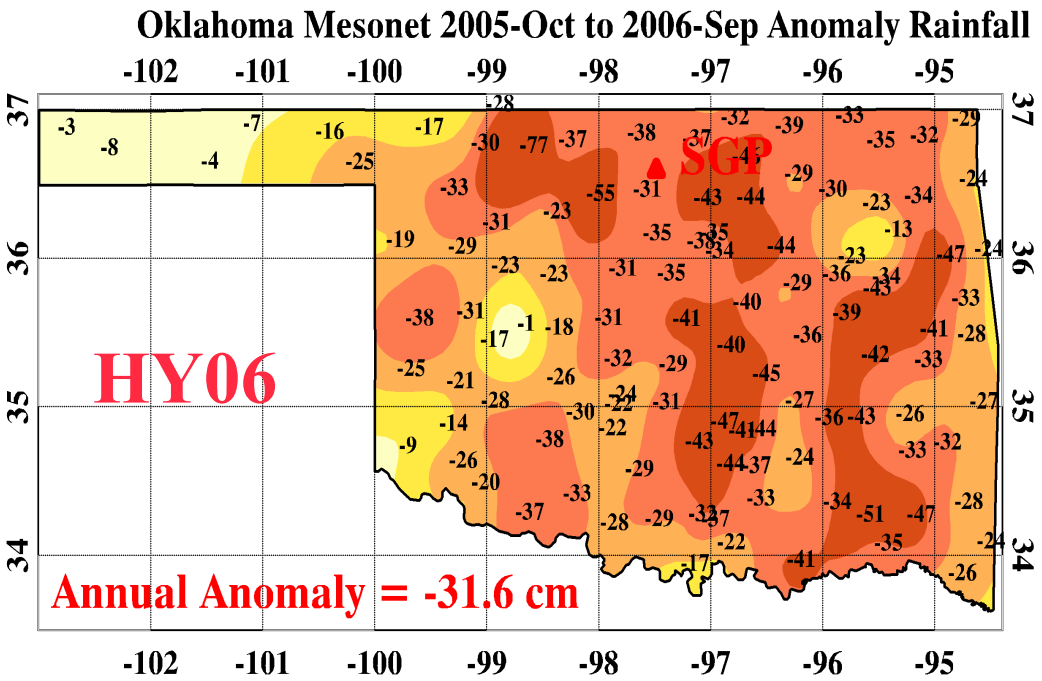
# Section 3: Publications (Cond')

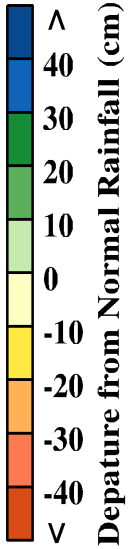
(should be submitted before next NEWS STM)

5. Bisher Imam, Zhe Feng, Eyal Amitai, and Xiquan Dong: Validation of Satellite-retrieved extreme precipitation using ground-based Observations
6. Joe Satanello and Christina Peters-Lidard: LoCo Diagnostics and LIS-WRF Experimental Design for the 2006-7 Period.
7. Yi Deng, Bing Lin, Bisher Imam, Ana Nunes, and Xiquan Dong: How do the regional extreme events link with continental and global scale processes?
8. Adam Schlosser, Dara Entekhabi, and Xiang Gao: Precipitation extremes and their climate analogues.
9. Eyal Amitai, W. Peterson, X. Llort. and S. Vasilof, Rainfall Intensities of extreme events

# Section 4: Plan for Future working group meetings

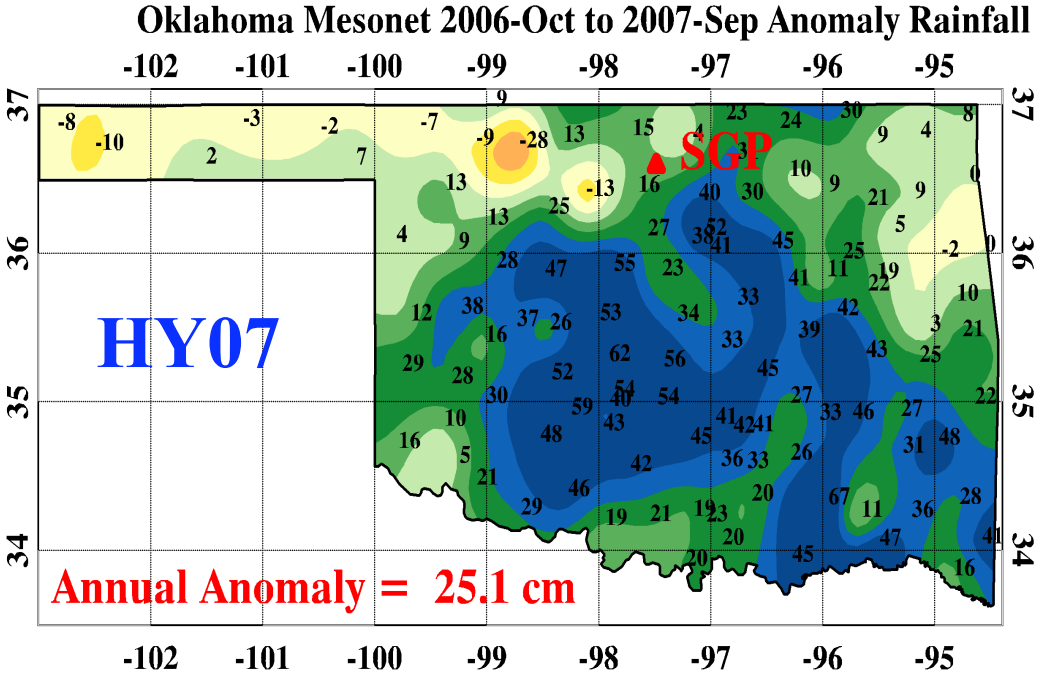
1) Since most of you do not have a chance to explore North Dakota summer (the most beautiful place to go during summer, NOT WINTER), Bob Shiffer and I discussed to offer an opportunity for you: What about we have another NEWS meeting at ND during next summer?
2) Soroosh strongly suggested to have a working group meeting during spring/summer, and he would like to host the meeting.

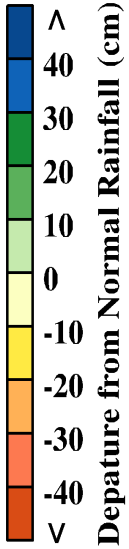



➔HY06 ranks as second-driest year over entire OK state.

➔HY06 precipitation is 32 cm below mean

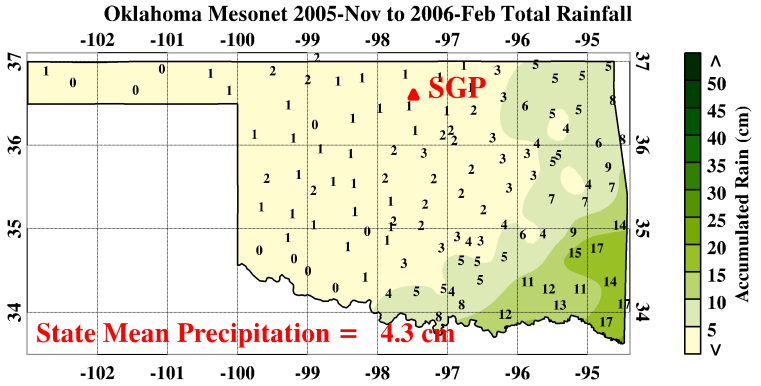


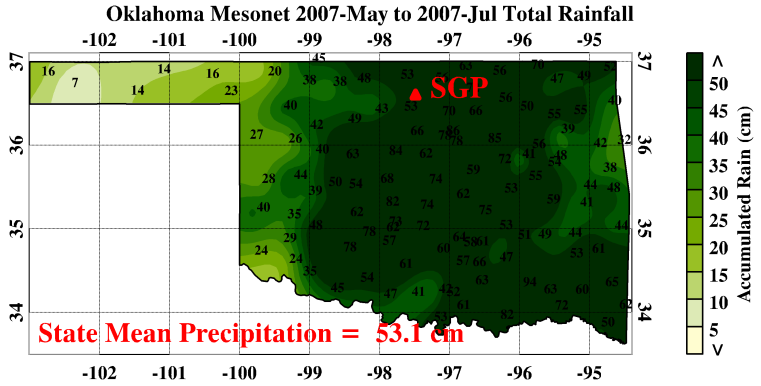



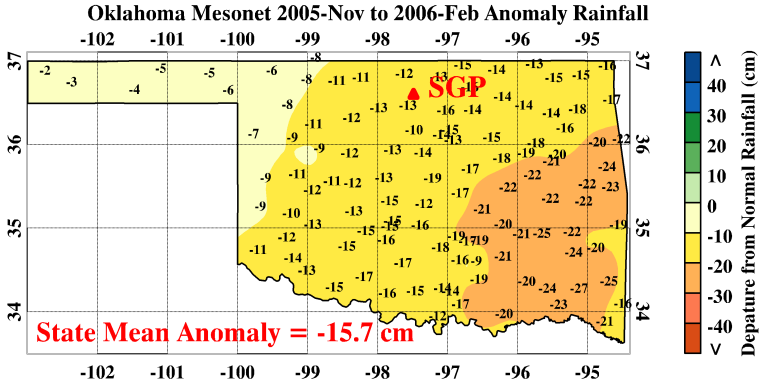

➔HY07 is seventh-wettest year over OK statewide and the wettest year over central OK.

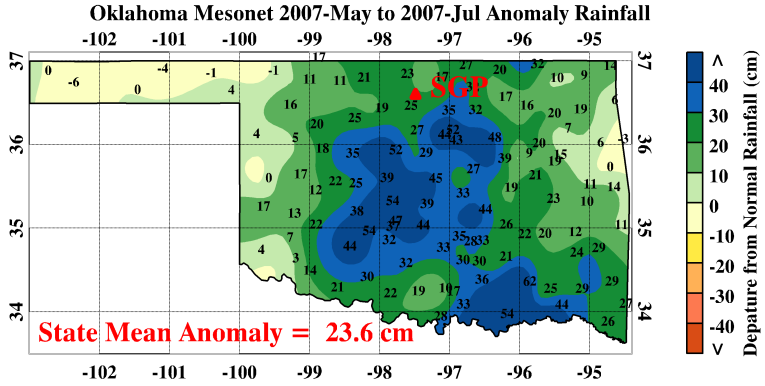
# Winter 05-06 is the first driest season, 81% below mean.

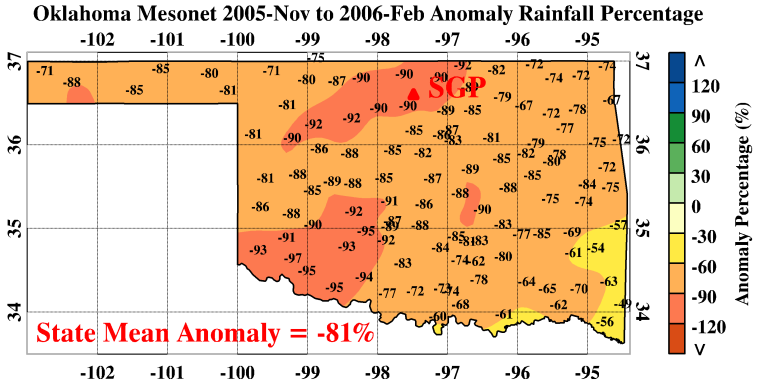
# Summer 07 is second wettest season, 79% above mean.

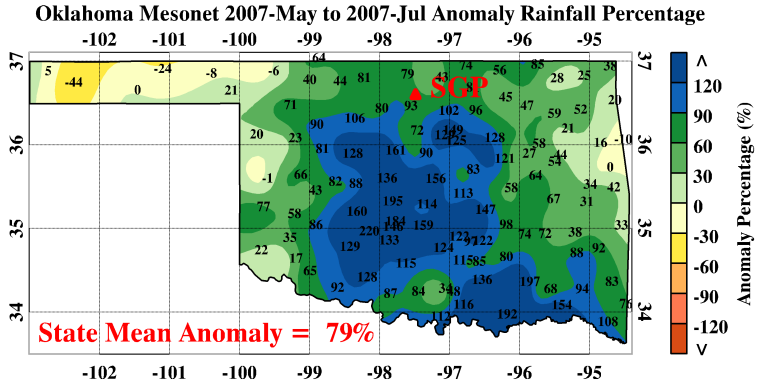


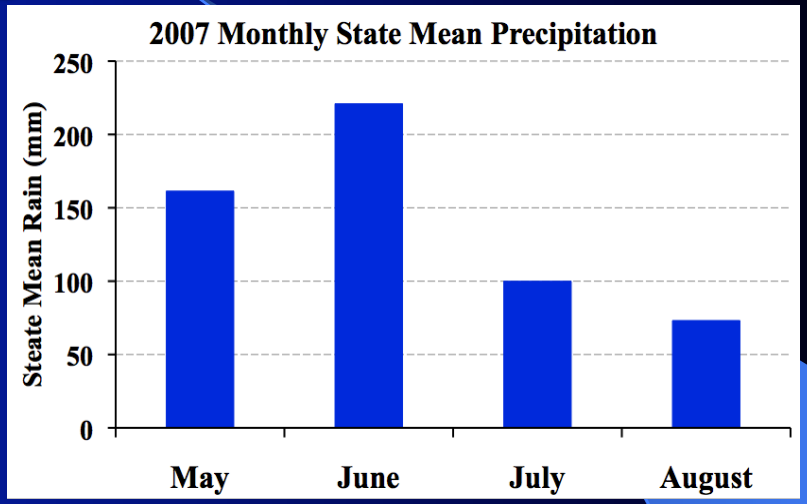



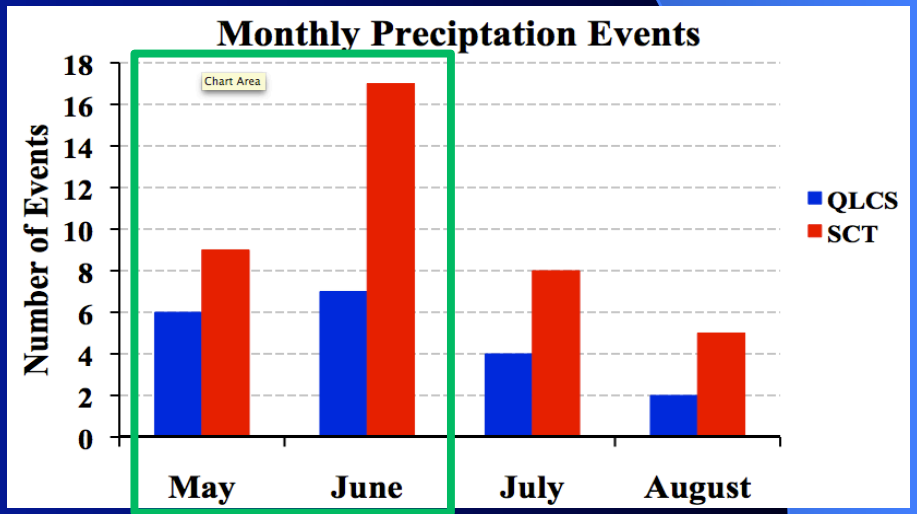



# 2007 Summer Season (May-July in this study)

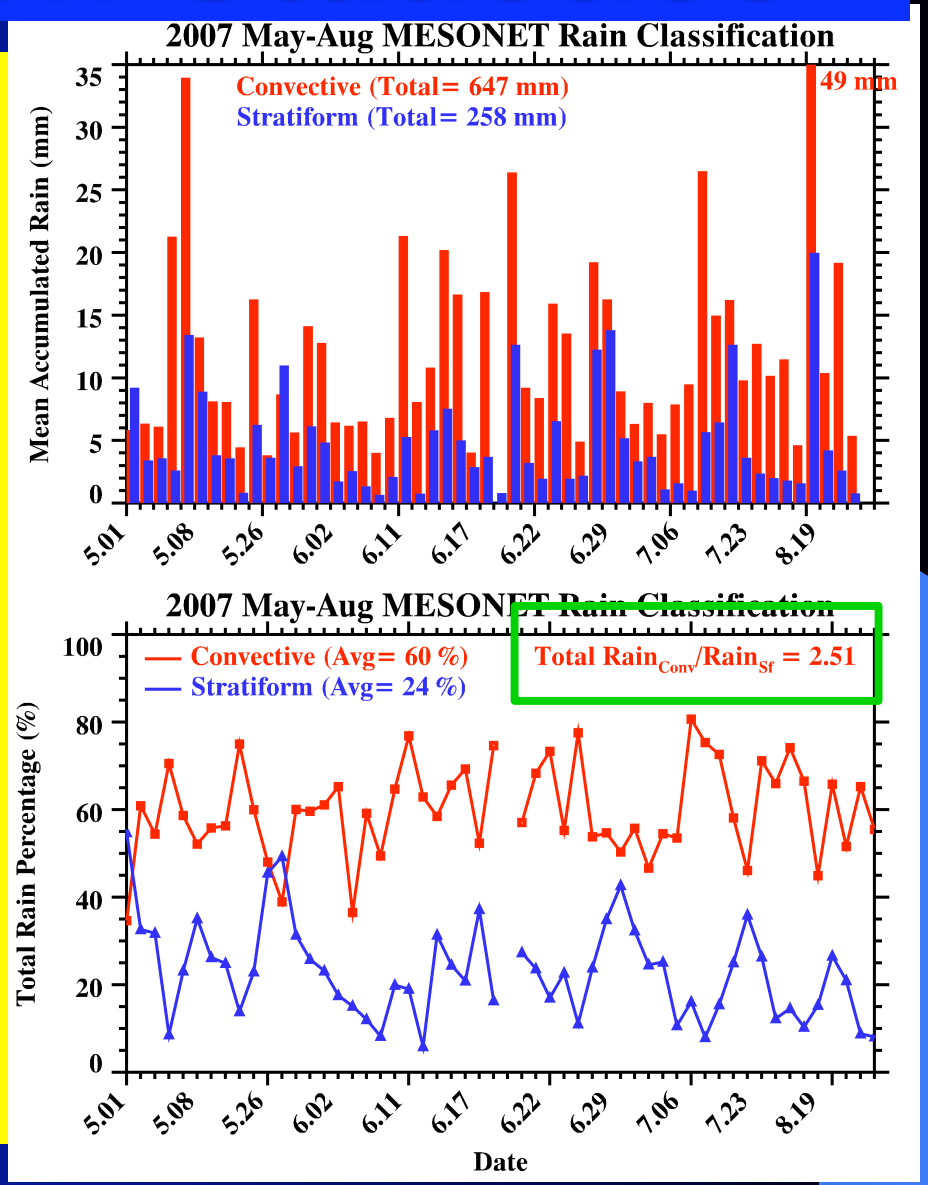
- The total precipitation during summer 2007 > 400 mm.
- Major precip events occurred during May-July 2007
- Multiple organized convective events (QLCS) occurred in May and June



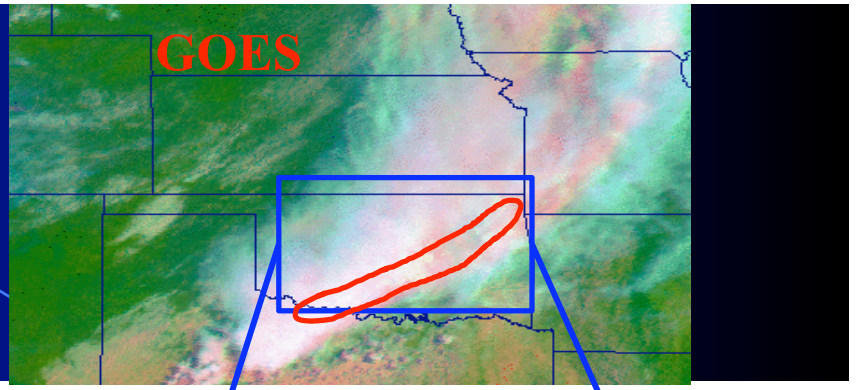
# 2007 Season Statistics

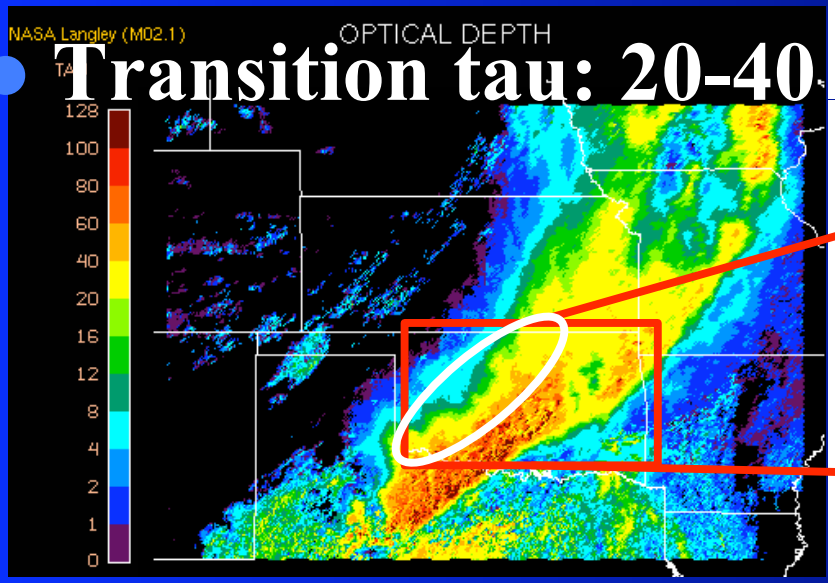
- **Convective rain** dominates the total precipitation in most events
- **Percentage of total rain:**
  - **60% convective**
  - **24% stratiform**
- **Convective to stratiform rain ratio: 2.5**

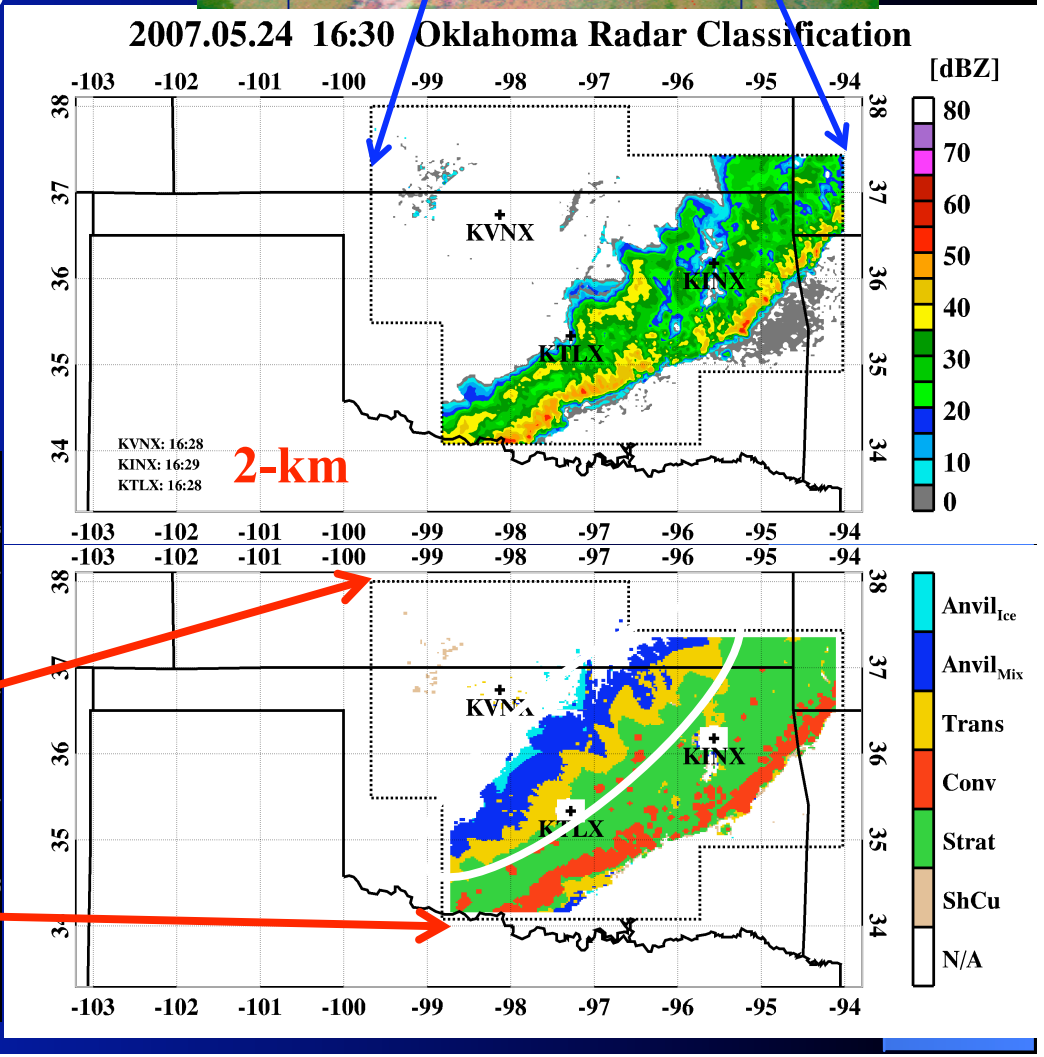


# Radar vs. GOES

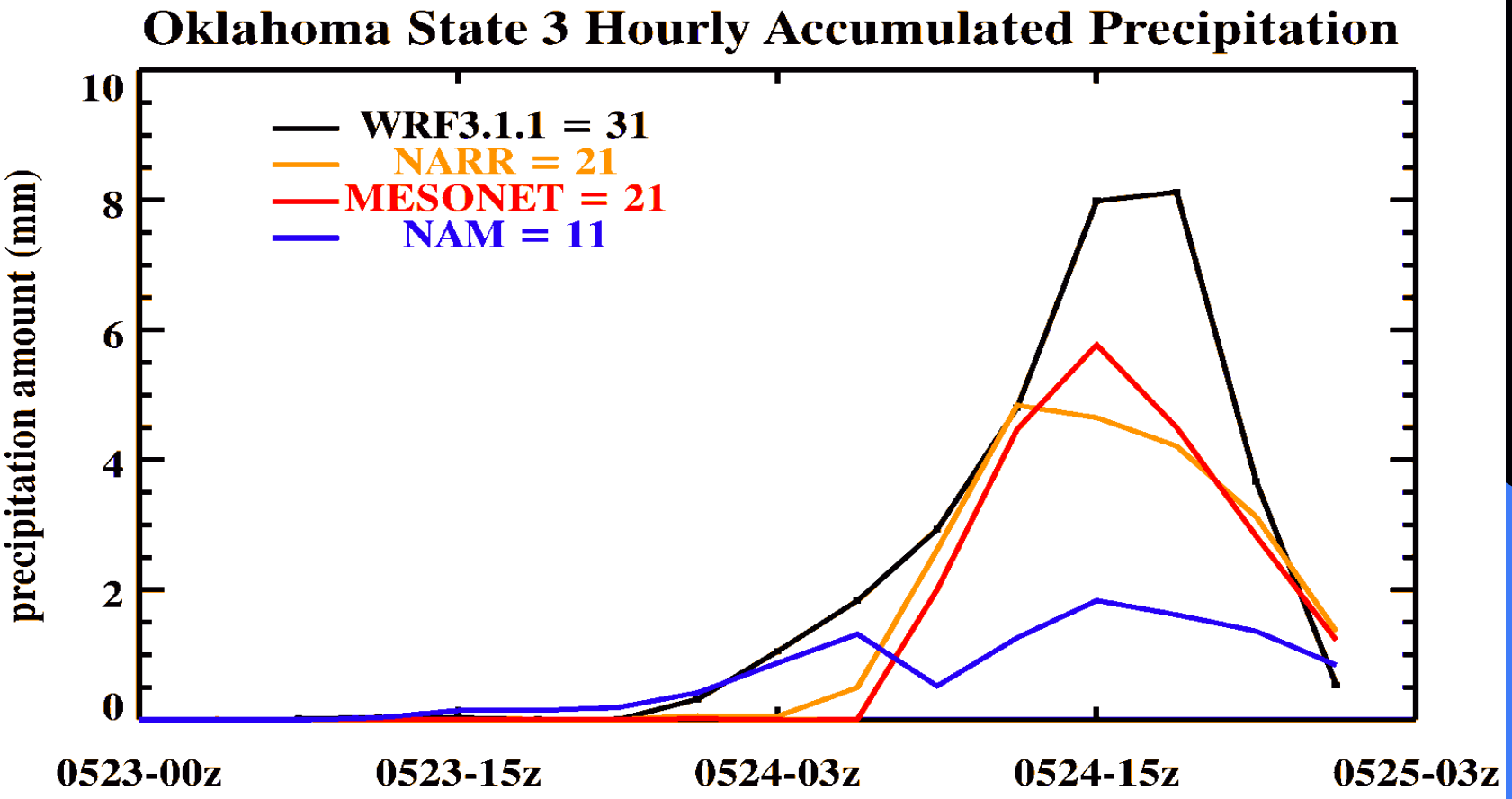
- Visible GOES image confirms anvil cloud, but cannot separate from leading squall line
- Anvil Tau:8-20
- Transition tau: 20-40



# Case 2: 3-hr accumulated Precipitation



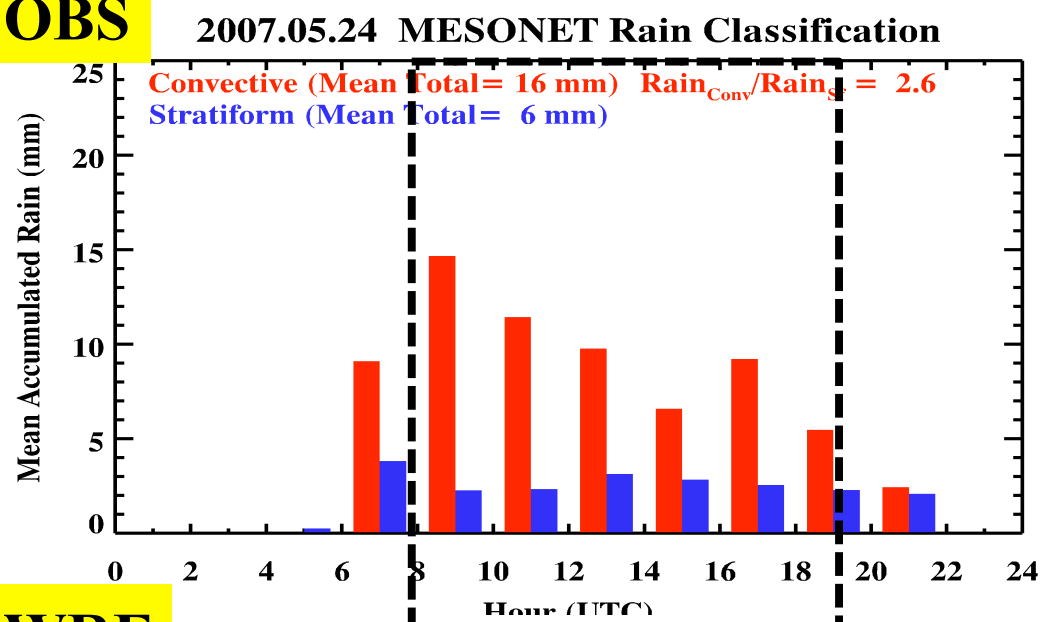

**Compared to the Oklahoma Mesonet Observations:**

**WRF: Over predicted the total precipitation by 50%**

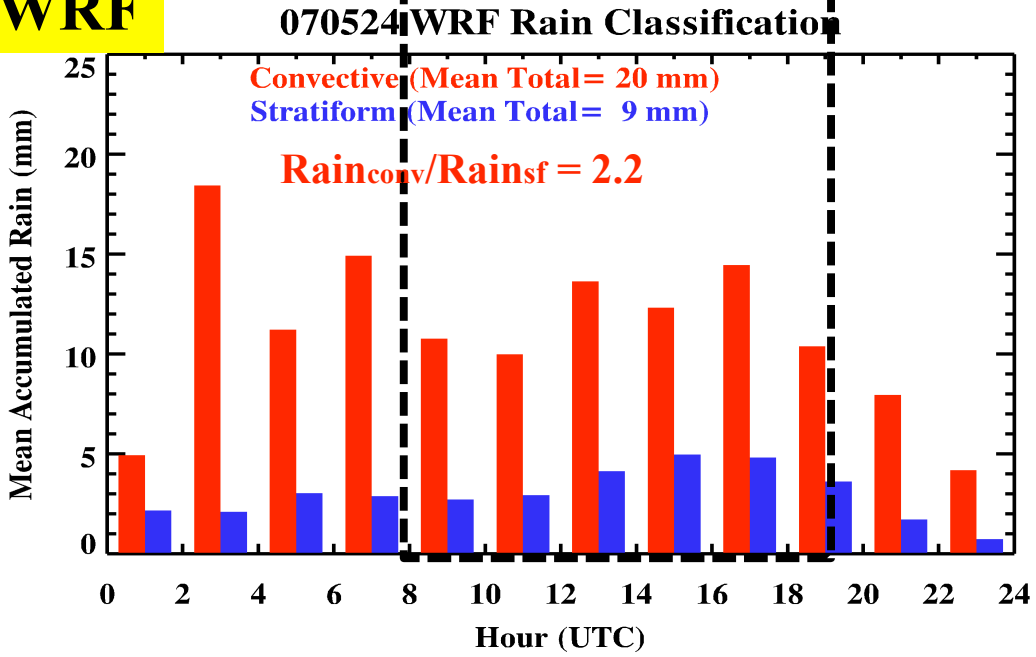
**NAM: Under predicted the total precipitation by 50%**

# Case 2: Convective and Stratiform Precipitation

**OBS**



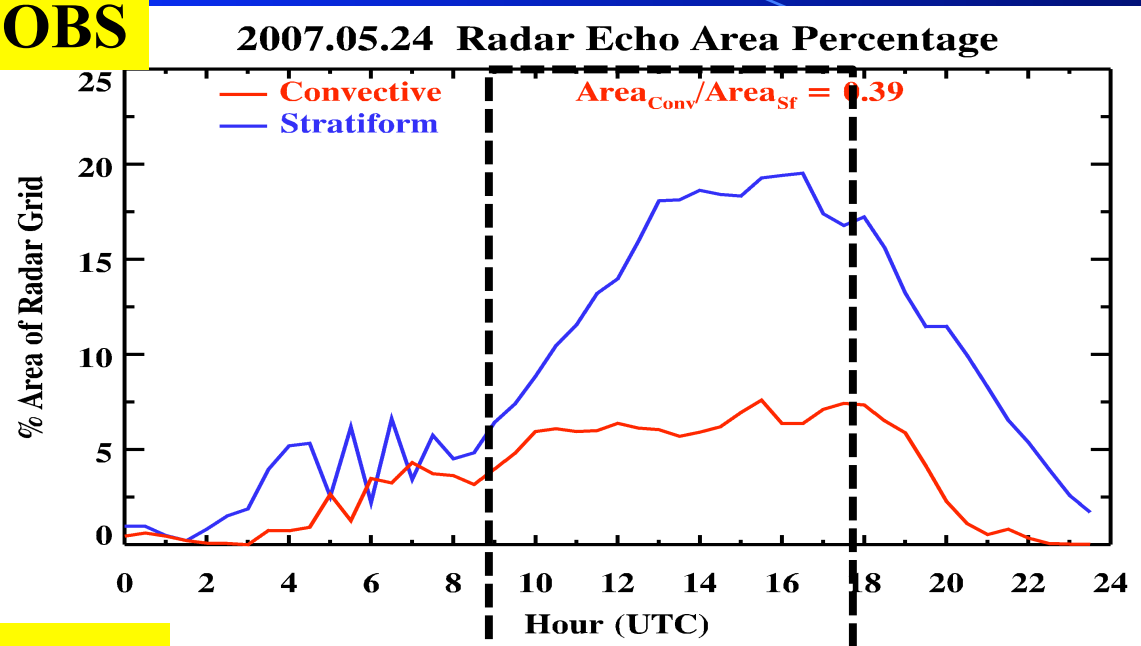

**WRF**



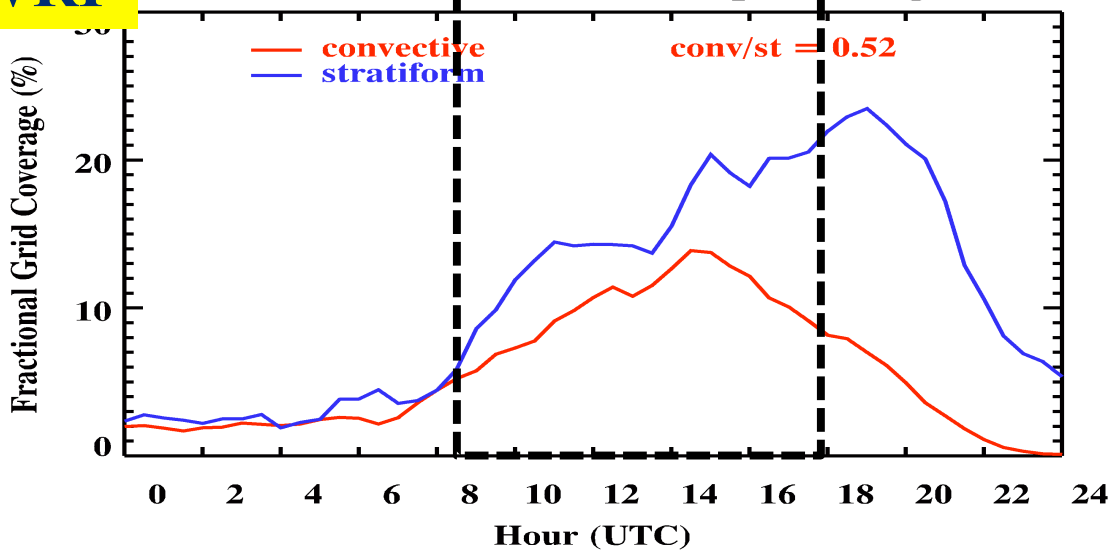

- The box indicates the same spatial domain covered by both NEXRAD and WRF over OK state.
- Both Observations and WRF have shown that convective precip. is dominant although their total precip. and trend are slightly different.

# Case 2: Areas covered by Con. and Strat.

**OBS**

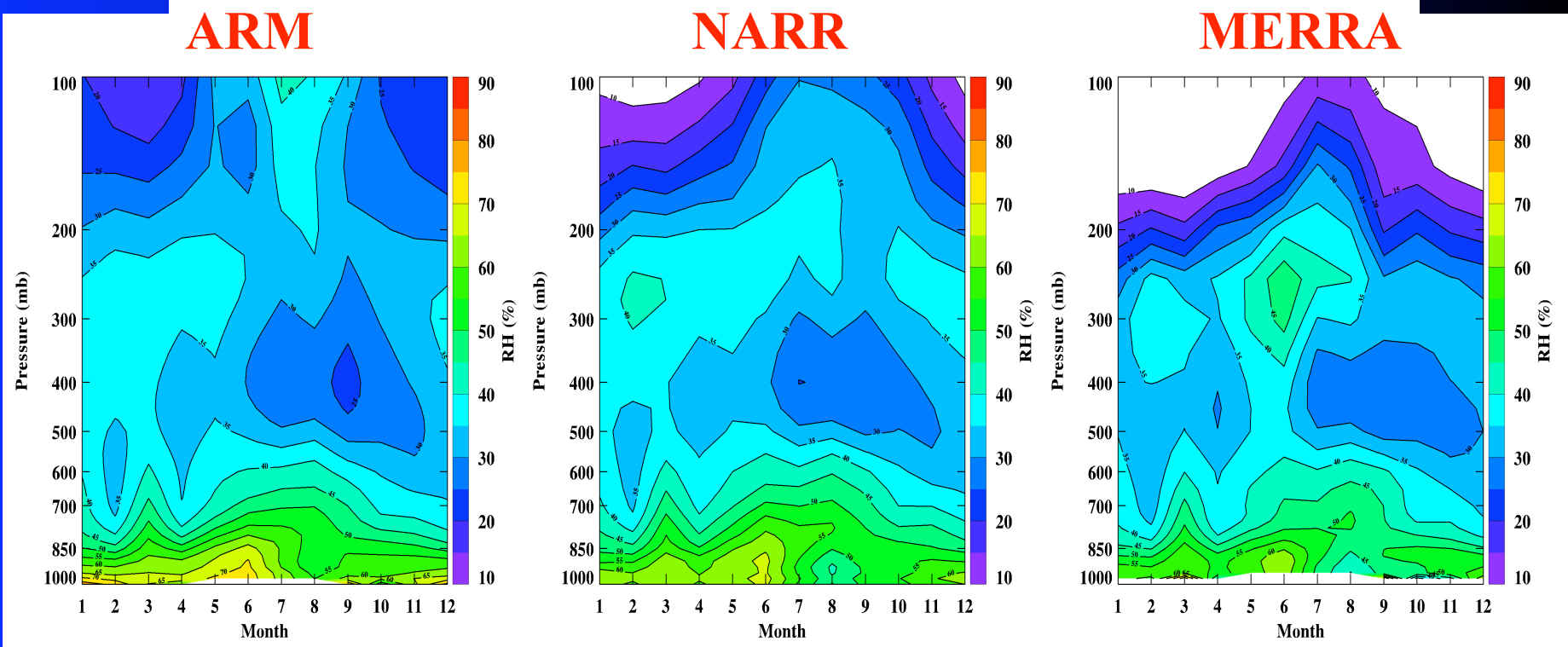



**WRF**



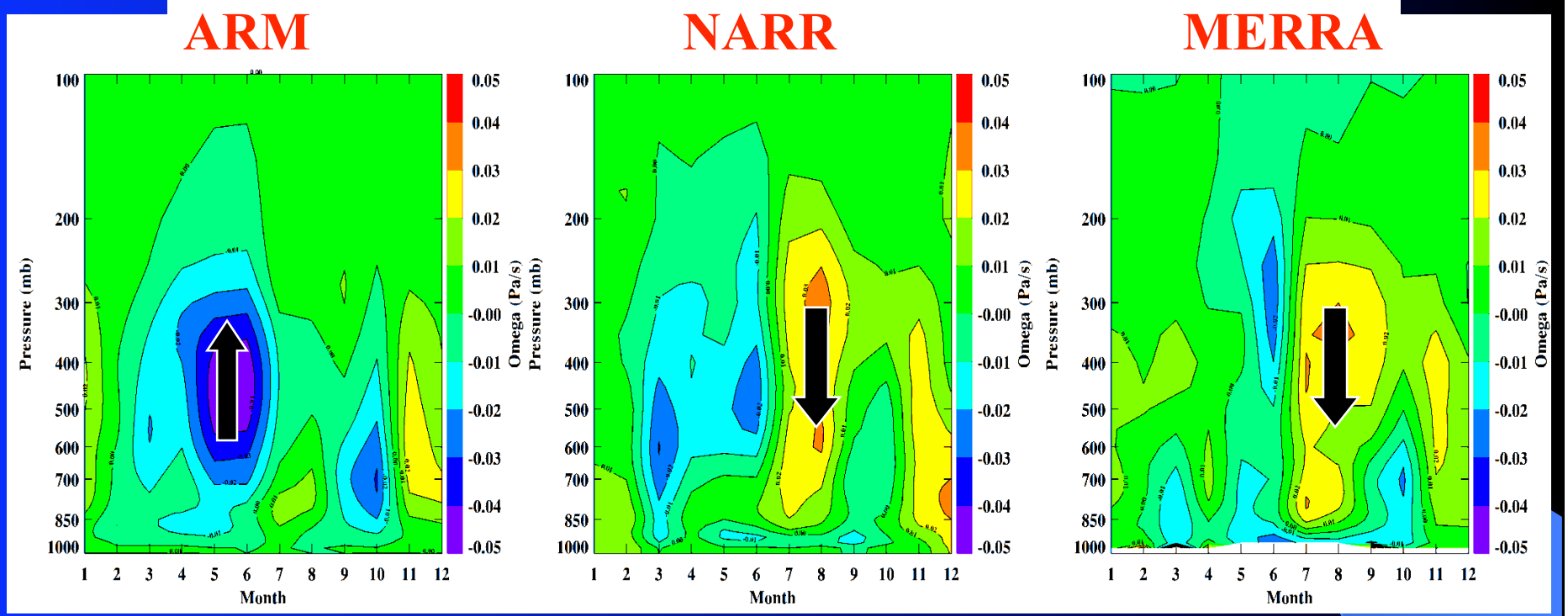

- **Stratiform precipitation covers much larger area than convective precipitation.**

# 3-yr averaged Atmospheric State (RH)




- Similar patterns for mean RHs in troposphere
- ARM slightly moister in boundary layer
- NARR and MERRA moister in upper troposphere during different months compared to ARM RHs

# Atmospheric State (ω)




- (-) upward motion, (+) downward motion
- Significant differences between all datasets
  - ARM has large upward maximum in upwelling during late spring
  - NARR and MERRA have weaker upward motion during late spring and large subsidence during summer.
- The model simulations could be significant difference based off the different forcing inputs.

# Summary

**Compared to the 3-yr ARM SGP observations, we have the following results for NARR and MERRA**

**1) Atmospheric State:**

**RH: Both NARR and MERRA are similar to ARM**

**ω : Significant differences between the three datasets**

**2) SW and LW fluxes:**

**MERRA has smaller bias than NARR**

**3) Cloud Fraction:**

**MERRA agrees reasonably well with ARM, but NARR underestimates CF**

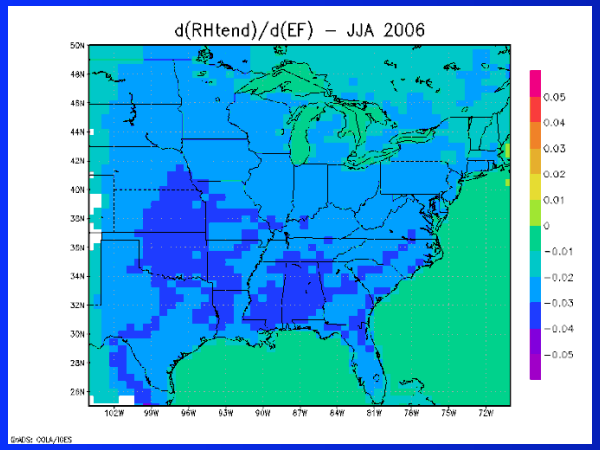
**4) Precipitation:**

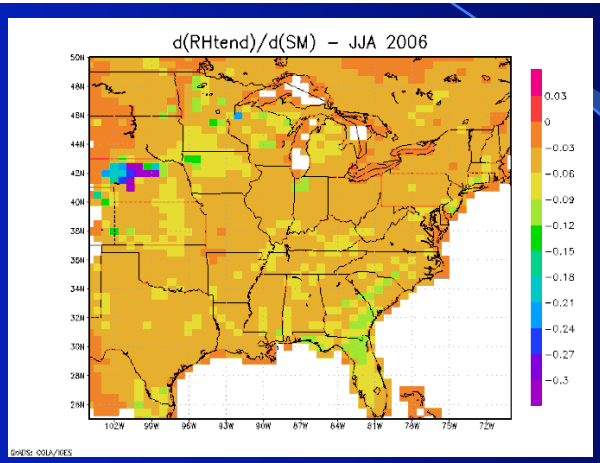
**NARR has an excellent agreement with ARM, but MERRA underestimates precipitation**

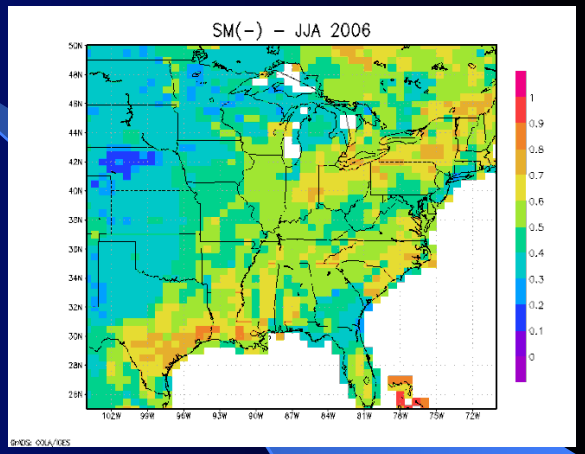
# NEWS Integration

- **Sensitivity of RH from MERRA for 2006-7 JJA periods**

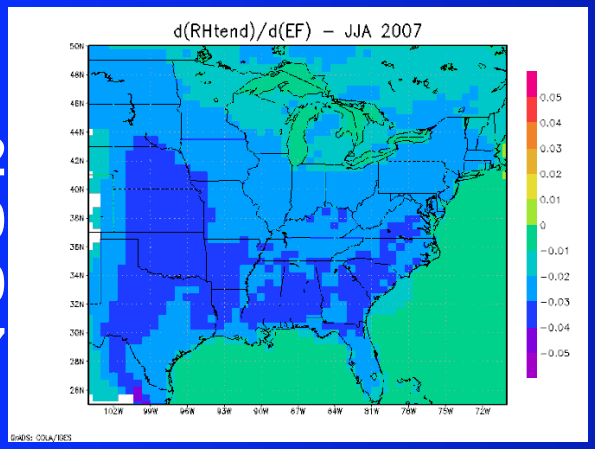
2006

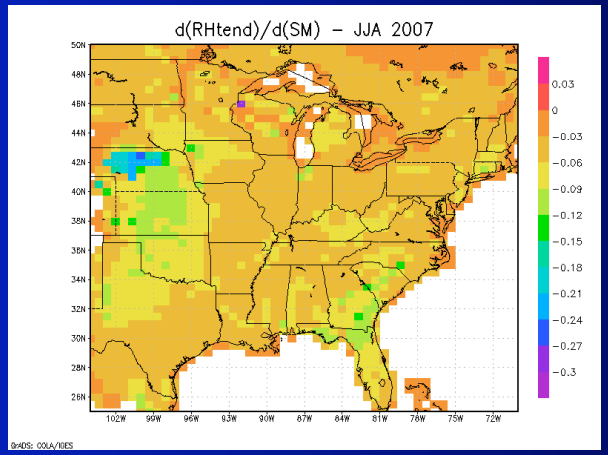


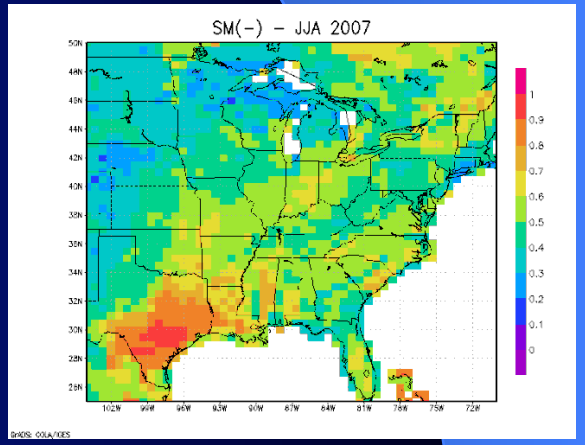




2007



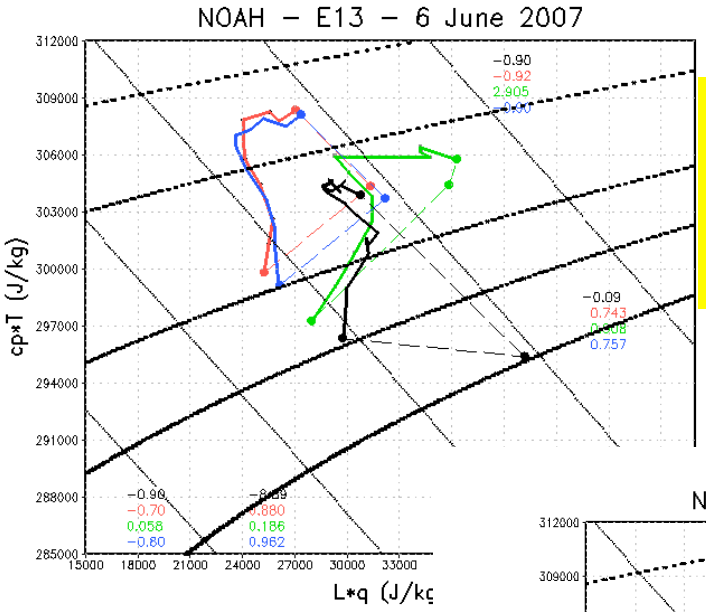




dRH/dEF

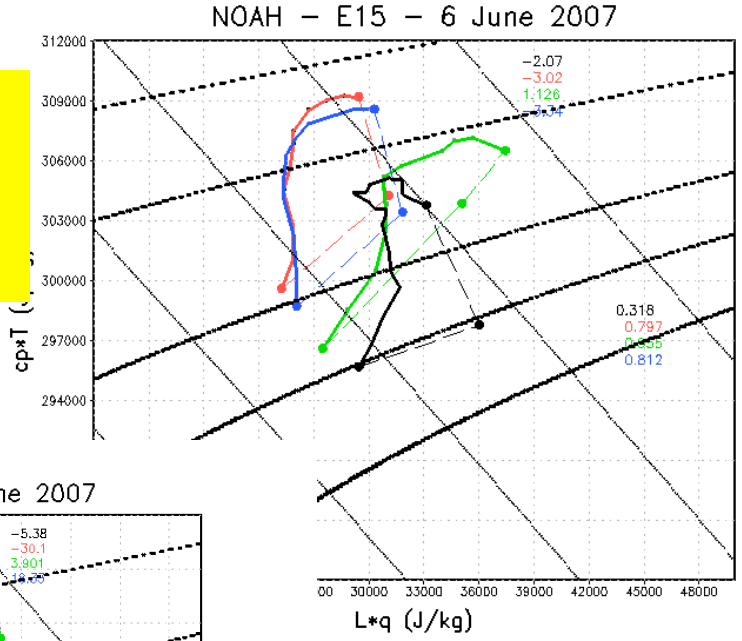
dRH/dSM

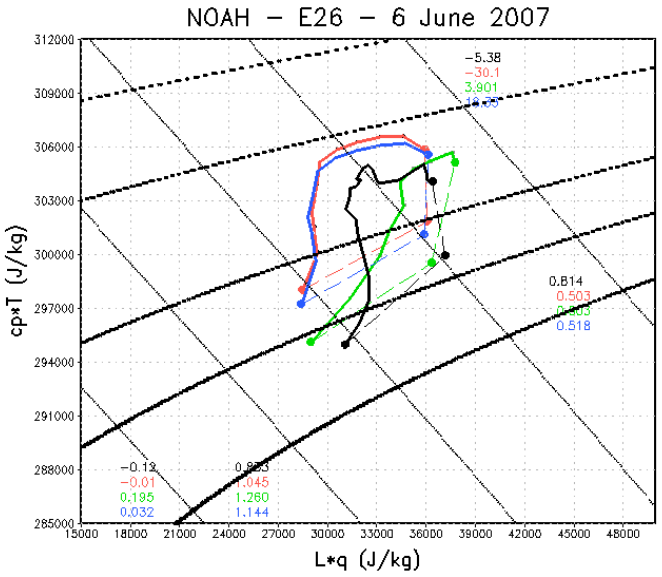
Soil Moisture

# Preliminary Results – LIS-WRF 6 June 2007




- = YSU
- = MYJ
- = MRF
- = OBS




- 6 June 2007
- Noah LSM w/3 PBL schemes
- E13, 15, 26 ARM-SGP sites

- Full 2006&2007 periods to be completed with new version of LIS(v6)-WRF(v3)

# Southern Great Plains Rain Extremes

# HYDROLOGIC BALANCE